

# **532-Q Laser**

## **User Manual**

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Version 1.1

**IMPEX Hightech GmbH**

Hovesaatstr. 6

48432 Rheine

Germany

Phone: +49(0)5971 981 650

FAX: +49(0)5971 981 659

- When the product is received, the shipping container and its content should be inspected for any damage incurred during shipping. In case of damage, please inform IMPEX – HighTech immediately!
- If any failure occurs, please contact IMPEX – HighTech immediately! Do not open the modules! They do not contain any user serviceable parts!
- Read this manual carefully before starting up the laser!
- Before connecting or disconnecting any cables, switch off the laser diode driver main power switch!
- Always wear suitable laser goggles to protect your eyes!

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## **1 User Safety**

The 532-Q Laser line is a OEM product out of the IMPEX – HighTech diode-pumped solid-state lasers. As such, it is intended only for integration into other equipment. The 532-Q Laser does not comply with Center for Devices and Radiological Health (CDRH) standards. The customer is responsible for CDRH certification of any system that incorporates the 532-Q Laser, if necessary.

### **1.1 Removing the cover**

**Warning:**

Do not remove the cover of the laser head. Dangerous radiation exists inside the laser head. Do not remove the cover of the control electronics. Dangerous voltages exist inside the control electronics.

### **1.2 Laser Safety Warnings**

**Warning:**

Exposure to laser radiation may be harmful. All apertures able to emit laser light in excess of levels considered safe are identified with appropriate labels shown later in this section. Take extreme care when working in areas where these labels are placed.

**Warning:**

Always provide protective eyewear suitable for the laser's emission wavelength. The emission wavelength of your laser model is given on the DANGER sticker at the side of the laser head.

**Warning:**

Use of controls or adjustments or performance of procedures different from those specified herein may result in hazardous radiation exposure. The use of optical instruments with these products will increase eye hazard.

**Caution:**

Lasers may be damaged by improper settings of the current or temperature controls or by improper use of the modulation input. Check line AC voltage settings before connecting power.

The positions of the laser safety and serial labels affixed to the laser cover of the 532-Q Laser are illustrated in the following Figure 1.1 and Figure 1.2.

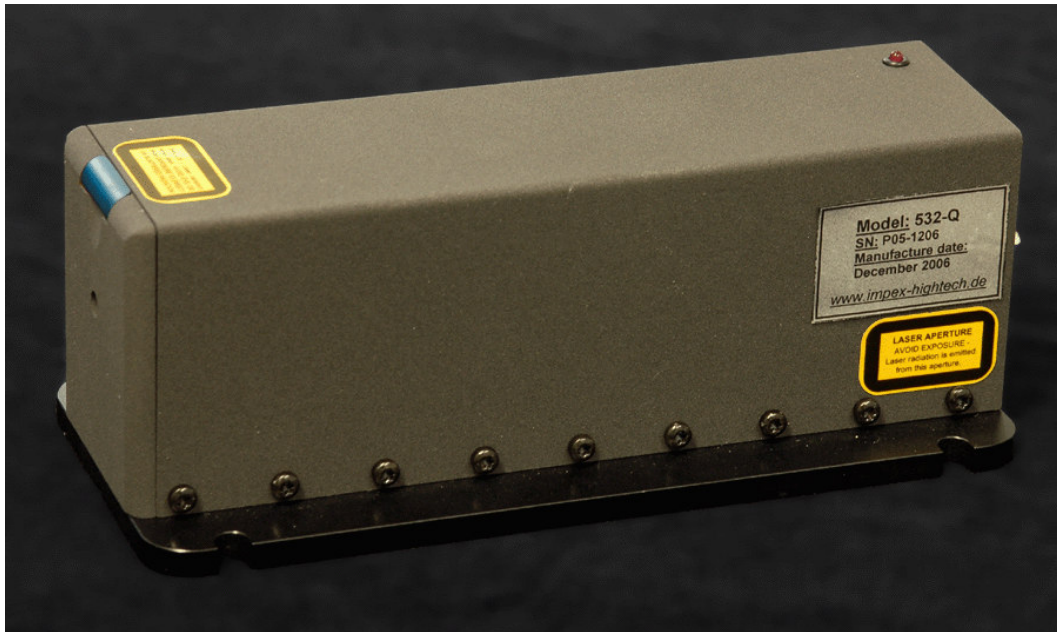


Figure 1.1 Laser head with serial label.

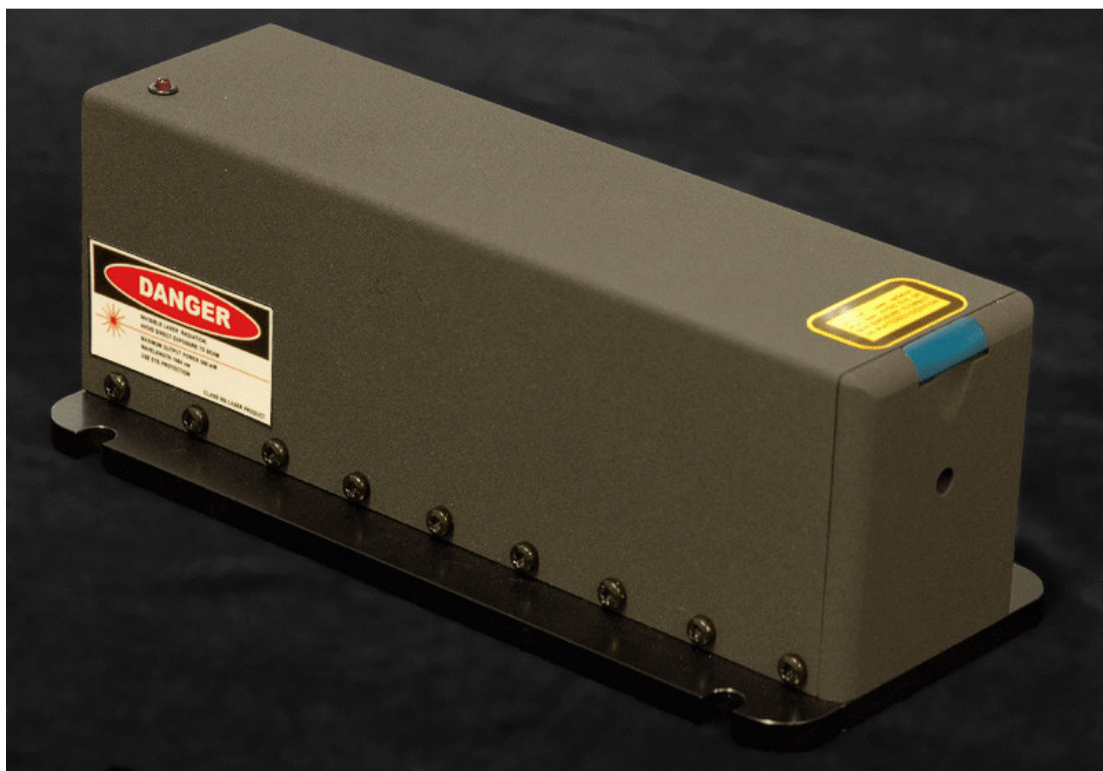


Figure 1.2 Laser head with safety label.

Reproduction of the laser safety labels and serial label for laser of 532-Q Laser are illustrated in the following Figure 1.3 to 1.6.

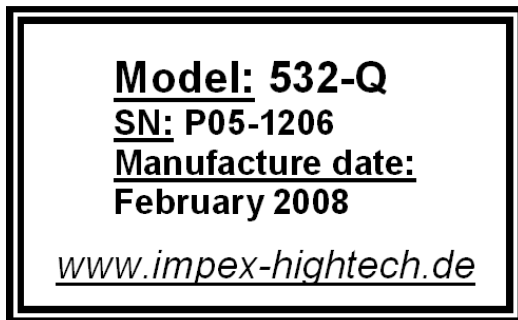


Figure 1.3 Laser serial label.



Figure 1.4 Laser safety label A.

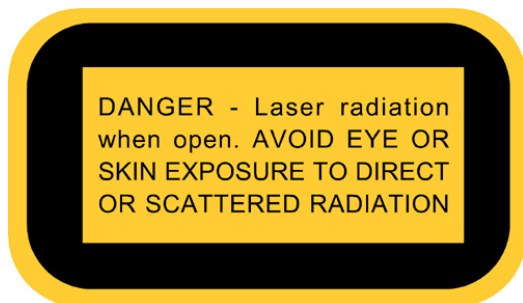


Figure 1.5 Laser safety label B (on side of the laser head cover near screw)

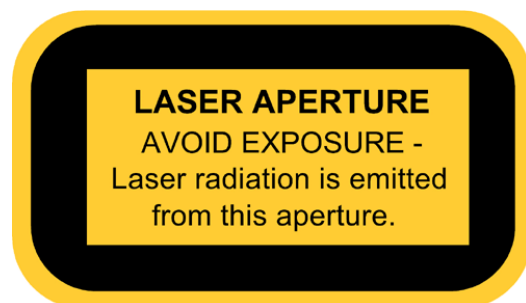


Figure 1.6 Laser safety label C (on top of laser head close to emitting laser aperture).

The maximum power level emitted from the 532-Q Laser and the class of the Laser is given at the laser safety label A (see Figure 1.4). This value is for pulsed operation under CW pumping as measured in average power mode. The emission wavelength of the 532-Q Laser is given at the Laser safety label A.

The Figure 1.3 shows the serial number of the laser, the manufacturing date and the Model of the Laser System. Also Impex HighTech internet address is given here to allow the customer for easy support access via internet.

The Figure 1.5 shows the DANGER label which is located close to one of the side screws which would be necessary to remove when someone would try to open the laser head. This is not allowed for the user because no customer adjustable part is inside the laser head. Only dangerous radiation can emit when opening the laser head!

The Figure 1.6 is the Laser safety label C and is located close to the laser aperture which emits the laser beam.

### 1.3 Servicing

There are no user replaceable parts inside the Laser head and control electronics unit. Refer all servicing to qualified personnel of IMPEX – HighTech.

### 1.4 Initial Activation

Read this manual carefully before initially operating the laser system.

## **2 The 532-Q Laser**

### **2.1 Packaging**

1. Laser head.
2. Laser diode driver A310.
3. Power cord.
4. Laser head 15-pin cable.
5. USB-cable.

### **2.2 Introduction**

The 532-Q Laser consists of two self-contained units, the laser head (see section 2.3) and the laser diode driver A310 (see section 2.4). This manual is intended to provide some more detailed information on how to operate these devices properly.

In the case of harmonic generation the laser head consists of the following components:

1. One is the electrically driven diode laser which provides the pump radiation for the active laser crystal.
2. Lens is used to focus the pump light into the active laser crystal.
3. Essentially the active laser crystal.
4. The nonlinear harmonic generation crystal placed after active laser crystal.

In order to operate the 532-Q Laser system the laser diode driver needs to be connected to a power network 90~264 VAC, 47~63 Hz by power cord (included in packaging). In turn the laser head needs to be connected to the laser diode driver by laser head cable (included in packaging). To work in remote control operation mode the laser diode driver needs to be connected to the PC by USB-cable (included in packaging).

The provided electrical power is converted into coherent laser radiation in the infrared (IR) spectrum. Some of the electrical power is needed for temperature stabilization of the diode laser and for temperature stabilization of the active laser crystal. The laser diode driver is designed to provide all subsystems to drive and control the 532-Q Laser system, featuring:

- A laser diode driver providing a very stable, low noise injection current to the laser diode.
- A laser diode driver providing pulsed injection current from adjustable offset current base with adjustable pump pulse length and repetition rate.
- A pulsed laser diode driver which can be triggered from external TTL signal.
- A precision temperature controller stabilizing the active laser crystal.
- A precision temperature controller stabilizing the laser diode temperature, so that the emission pump wavelength of the laser diode stays stable in the maximum absorption bandwidth of the active laser crystal.
- A feedback loop to keep the output level at a stable level and to compensate for fast variations of the laser diode emission intensities.

### 2.3 The 532-Q Laser Head

The dimensions of a laser head of the 532-Q Laser are illustrated in the following Figure 2.1. The laser beam is emitted from the laser aperture at the front side of the laser head.

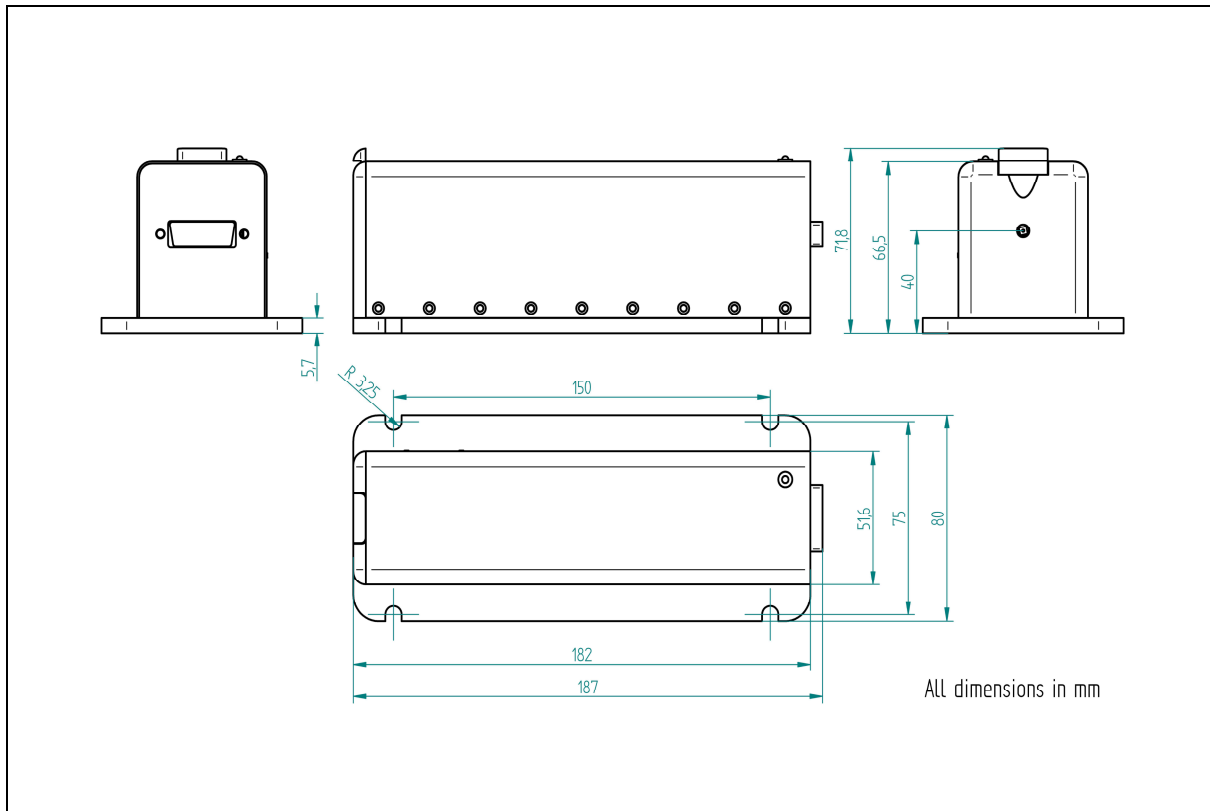


Figure 2.1 Dimensions of the 532-Q Laser head.

At the rear side of the laser head, a 15-pin male D-sub connector is located, which needs to be connected with the Laser cable (15-pin D-sub female connector). The other side of the Laser cable is split into two D-sub male connectors. The 9 pin connector needs to be connected to the TC (temperature controller) plug at the rear side of the electronics panel and the 15 pin connector needs to be connected to the LD (Laser Diode) plug at the rear side of the electronics driver.



## 2.4 532-Q Laser diode driver

In the 532-Q Laser used the laser diode driver A310. For all technical and usage data, please, see the user manual of laser diode driver. The photo of the driver is shown below on the Figure 2.2. The dimensions of the driver are shown on the Figure 2.3.

Below the rear and the front panels of the driver are shown (Figures 2.4 and 2.5).



Figure 2.2 Photo of laser diode driver.

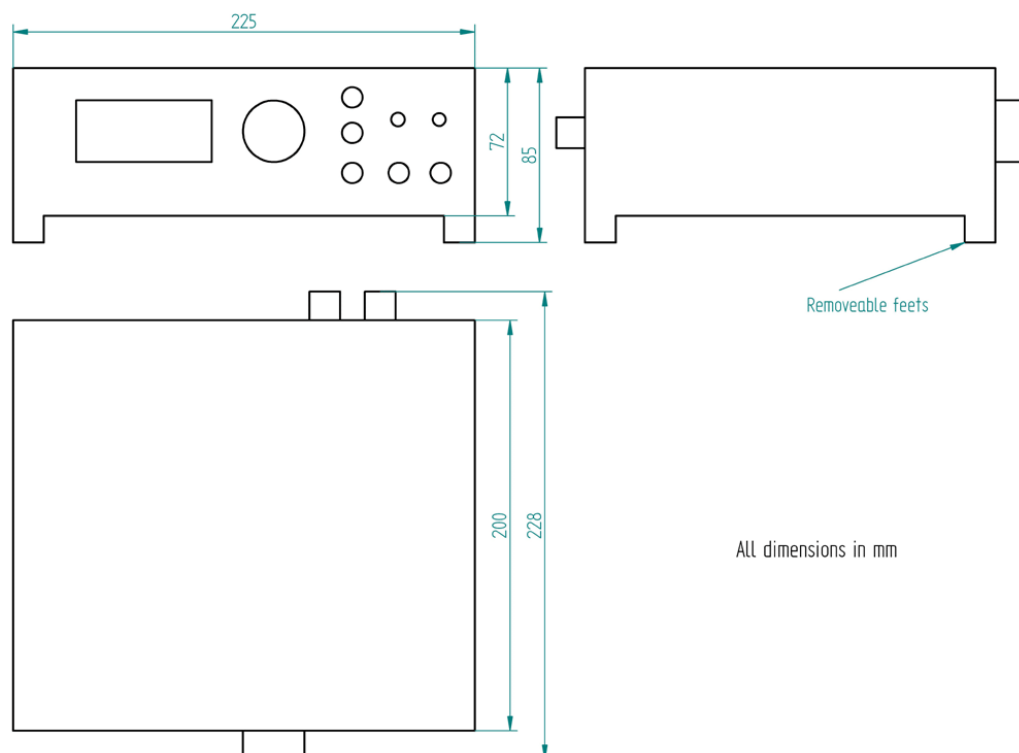


Figure 2.3 Dimensions of the laser diode driver.

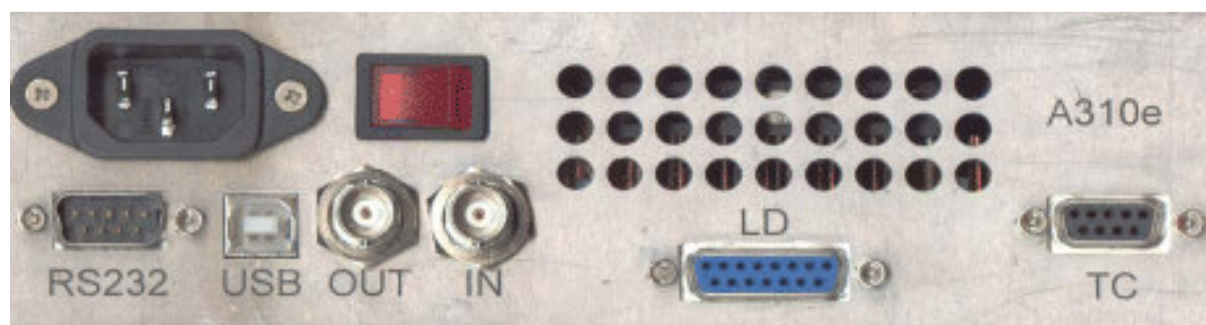


Figure 2.4 Rear panel of the laser diode driver.

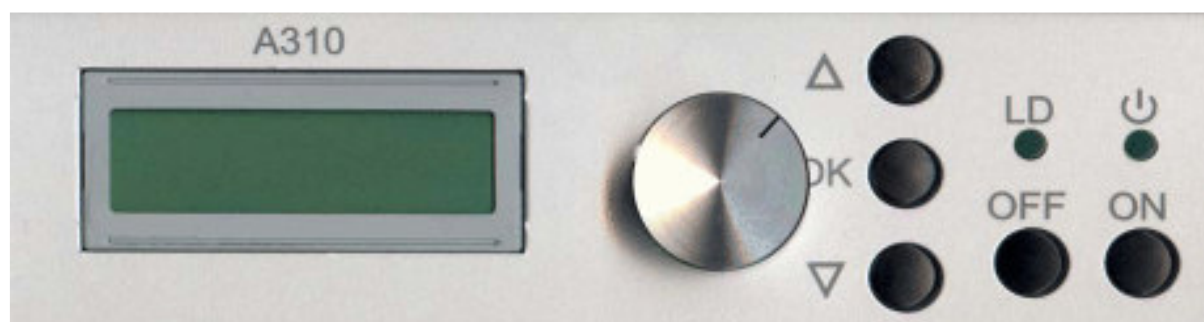


Figure 2.5 Front panel of the laser diode driver.

### 3. Operating the 532-Q Laser

#### 3.1 Installing the 532-Q Laser

Before connecting any power to the laser diode driver or to the laser head make sure that the laser head is fixed in proper position using the 6 mm diameter half-holes at the bottom plate of the laser head. See the Figure 2.1 for exact information on the dimensions of the laser head. Make sure that the laser aperture and so the laser beam is directed to a secure target so that no dangerous radiation can be emitted by the laser to anyone or anything. Make sure that no static discharge voltage will be supplied to the laser head.

It is recommended to place the laser head onto a metal ground plate to provide additional heat sink. The thermal management inside the laser head is calculated in such way that additional heat sink is needed at high power levels and high environmental temperatures. The laser diode driver box does not need any additional heat sink.

Remove the safety lock from the laser head plug (which shortens the laser diode during transport to protect from static discharge). Connect the female end of the included 15-pin laser head cable to the laser head. The other end of the cable is split into two plugs. One of them (with 15 pins) needs to be connected to the LD connector at the rear panel of the laser diode driver (see Figure 2.4). The other plug (9 pins) needs to be connected to the TC connector at the rear panel of the laser diode driver. Fix all plugs with their screws.

Connect the laser diode driver to the power network by using included power cord.

#### 3.2 Standalone operation

Turn on the power switch located on the rear panel of the laser diode driver (see Figure 2.4). LCD display shows **COOLING** status. The **Power** LED starts blinking indicating temperature conditioning status. The **ON** button is disabled while temperatures are not in condition.

The stabilization time depends on the temperature difference at which the system was stored and on the PID parameters (see page 14 of this manual).

Wait until the **Power** LED lights permanently, **LD** LED starts blinking and LCD Display shows **READY ON** status, indicating normal temperature condition. The **ON** button is enabled. Initially driver loaded with default configuration. Use Menu to change default configuration or to load previously saved one. For details of using Menu see Laser Diode Driver A310 User Manual, page 9.

Now open the shutter: pull up the blue plate above the emitting aperture. The 532-Q Laser is now ready for Laser emission, if you press the **ON** button.

### 3.3 Remote control operation

For remote control operation use included USB-cable to connect the laser diode driver to PC with installed remote control software. Launch the A310 Remote Control software.

#### 3.3.1 Installing the remote control software

For the installation of the remote control software it is required to install the application itself and the correct USB driver support. Please follow the installation instructions given in the A310 electronics manual to install the software.

#### 3.3.2 The remote control software

The remote control software has three windows. One is the main and has the title «Remout Control Unit Ver.4.0.6». Remaining two are subsidiary windows which are for monitoring the

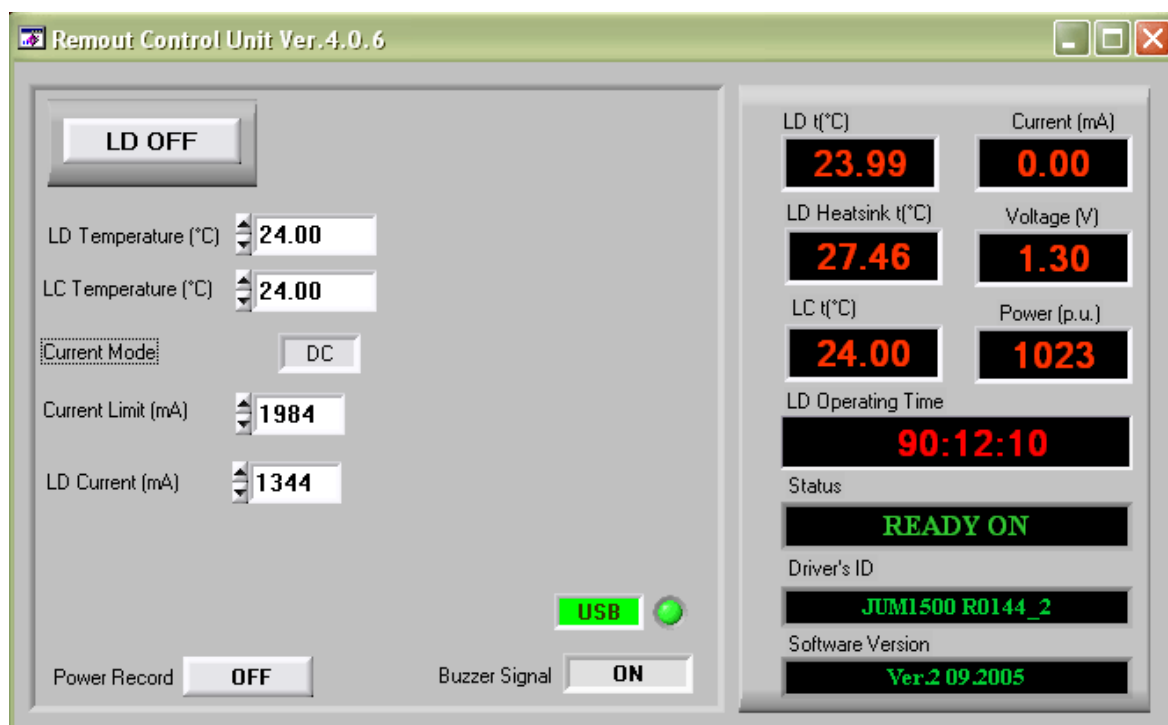


Figure 3.1 The main window of the A310 Remote Control software. CW mode of operation.

temperature control only. The one has the title «Peltie correction» and the other — «Cooler Controls». At the start only the main window is shown (see Figure 3.1). Initially default configuration is loaded. To call «Peltie correction» window press the Ctrl+F10 combination having the main window active. To call «Cooler Controls» window press button «Show controls» in the «Peltie correction» window.

**NOTE.** It is strongly recommended to use only the main window for adjusting the settings parameters. The temperature windows just shall be used to monitor the temperature controls.

#### The main window «Remout Control Unit Ver.4.0.6»

The main window has two areas: right indicating part and left driving part (see Figure 3.1). The content of the indicating part is listed in Table 3.1.

Table 3.1 The content of the indicating part of the main window

<b>LD t(°C)</b>	laser diode present temperature
<b>Current (mA)</b>	laser diode present current
<b>LD Heatsink t(°C);</b>	laser diode heat sink temperature
<b>Voltage (V)</b>	applied laser diode voltage
<b>LC t(°C);</b>	active laser crystal temperature
<b>Power (p.u.);</b>	loaded power
<b>LD Operating Time</b>	the time (minutes:seconds:split seconds) of laser diode continuous operating
<b>Status</b>	the current laser diode status (duplicates the status on the laser diode driver LCD Display)
<b>Driver's ID</b>	laser diode identification data
<b>Software Version</b>	

Table 3.2 The permanent content of the driving part of the main window

<b>LD ON/OFF Button</b>	Duplicates the laser diode driver <b>ON</b> and <b>OFF</b> buttons to run/stop laser generation. It is grey and unpressed when laser is off. It is green and depressed when laser is on.
<b>LD Temperature t(°C)</b>	For set up laser diode work temperature
<b>LC Temperature t(°C)</b>	For set up active laser crystal work temperature
<b>Current Mode Button</b>	Switches between CW and pulsed modes of laser diode operation.
<b>Current Limit (mA)</b>	For set up maximum permitted laser diode current
<b>USB indicator</b>	Shows the USB connection state. Green if it functions properly. Red blinking with «RECONNECT» label when connection is failed
<b>Power Record Button</b>	Under development
<b>Buzzer Signal Button</b>	To switch OFF the fault buzzer signal

The content of the driving part in turn divided into permanent and variable parts. Permanent content is listed in the Table 3.2. Variable content depends on the operation mode. There are two possible modes of operation for 532-Q Laser: CW pumping (the laser diode emits continuously) and pulsed pumping (the laser diode emits the sequence of rectangular pulses).

To change operation mode press **Current Mode** button in the left area of the main window. In the case of CW mode it became depressed with **DC** label. The laser diode continuously emitted. The view of the main window in this case is shown on Figure 3.1.

There is only one element of the variable content in CW mode of operation. It is **LD Current** for set up the required laser diode current. If the value of set current exceeds **Current Limit** value it is automatically reduced to preset value of **Current Limit**.

### Warning

Do not increase the preset value of the **Current Limit (mA)**. It can result in laser diode damage.

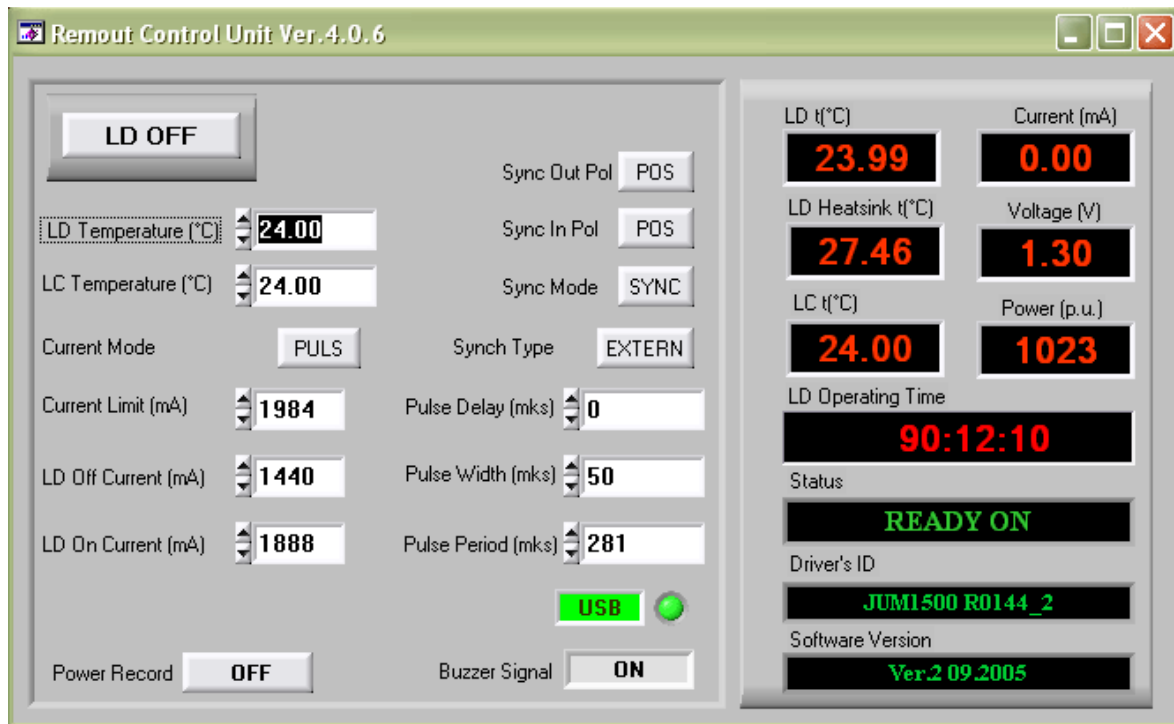


Figure 3.2 The main window of the A310 Remote Control software. Pulsed mode of operation.

To change operation mode press **Current Mode** button. In the case of pulsed mode it became unpressed with **PULS** label. The view of the main window in this case is shown on Figure 3.2. The variable content of the driving part is listed in Table 3.3.

Table 3.3 The variable content of the driving part of the main window. Pulsed mode of operation

<b>LD Off Current (mA)</b>	For set up laser diode current level between pulses
<b>LD On Current (mA)</b>	For set up laser diode current level at the top of the pulse
<b>Sync Out Pol</b> Button	The out polarity of synchronization (positive/negative)
<b>Sync In Pol</b> Button	The input polarity of synchronization (positive/negative)
<b>Sync Mode</b> Button	The mode of synchronization
<b>Synch Type</b> Button	The type of synchronization (external/internal)
<b>Pulse Delay (mks)</b>	The delay from triggering event to the begin of pulse
<b>Pulse Width (mks)</b>	Laser diode current pulse width
<b>Pulse Period (mks)</b>	Laser diode pulse repetition period

**NOTE.** Units from **Sync Out Pol** to **Pulse Delay** are intended to work in synchronization mode. For details see, please, Laser Diode Driver A310 User Manual, pages 5-6.

### The subsidiary window «Peltie correction»

The view of the subsidiary window «Peltie correction» is shown on Figure 3.3. The content of the window is listed in Table 3.4.

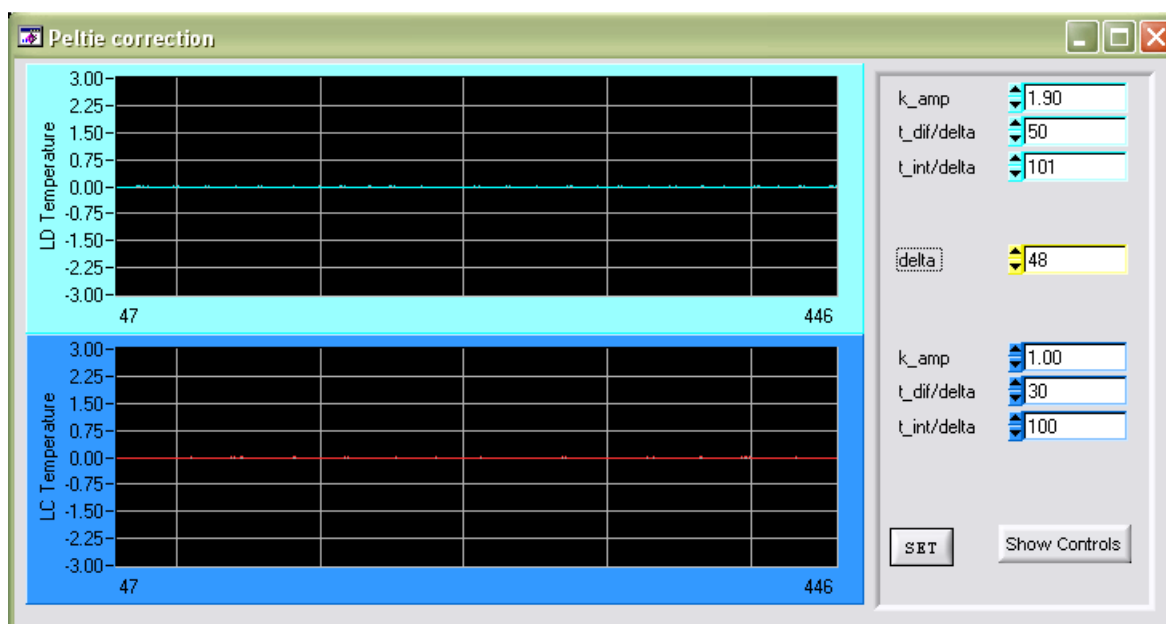


Figure 3.3 The subsidiary window «Peltie correction» of the A310 Remote Control software.

Table 3.4 The content of the subsidiary window «Peltie correction»

<b>LD Tempetarure</b> time depended graph	Shows changes (in °C) in laser diode temperature
<b>LC Temperature</b> time depended graph	Shows changes (in °C) in active laser crystal temperature
<b>k_amp</b> (cyan)	The amplitude coefficient of PID-control (Proportional Integral-Derivative control) for laser diode temperature
<b>t_dif/delta</b> (cyan)	The differential coefficient of PID-control (Proportional Integral-Derivative control) for laser diode temperature
<b>t_int/delta</b> (cyan)	The integral coefficient of PID-control (Proportional Integral-Derivative control) for laser diode temperature
<b>delta</b>	Correction factor (do not change)
<b>k_amp</b> (blue)	The amplitude coefficient of PID-control (Proportional Integral-Derivative control) for active laser crystal temperature
<b>t_dif/delta</b> (blue)	The differential coefficient of PID-control (Proportional Integral-Derivative control) for active laser crystal temperature
<b>t_int/delta</b> (blue)	The integral coefficient of PID-control (Proportional Integral-Derivative control) for active laser crystal temperature
<b>SET</b> button	Should be pressed to accept the new settings for any of the PID-controls
<b>Hide/Show Controls</b> button	Hide/show the subsidiary window «Cooler Controls»

**NOTE.** PID-control is intended for adjustment of TEC temperature response to the TEC driving current.

### The subsidiary window «Cooler Controls»

The view of the subsidiary window «Cooler Controls» is shown on Figure 3.4. The content of the window is listed in Table 3.5.

This window allows to watch the tendency of the both TECs heat load and to prevent its overheating. The best conditions for TEC are when the extensive changes of current are in the limits of  $\pm 85\%$ .

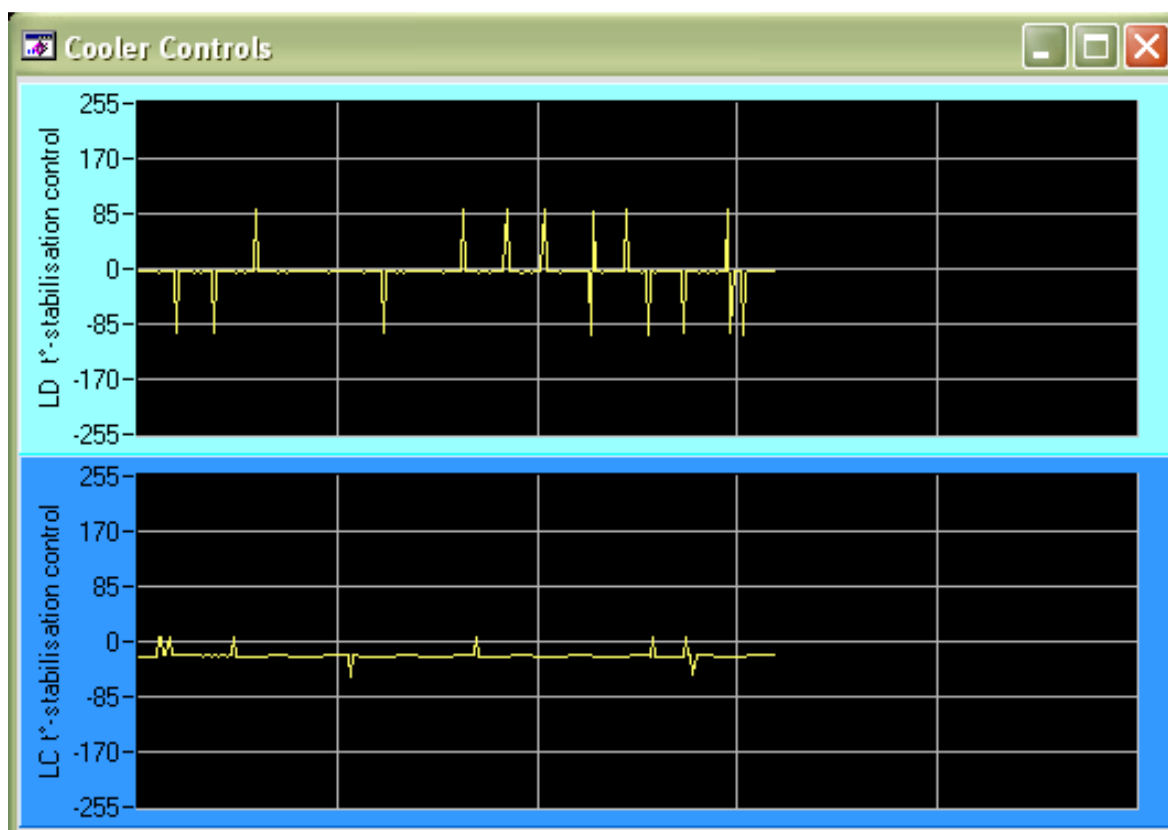


Figure 3.4 The subsidiary window «Cooler Controls» of the A310 Remote Control software.

Table 3.5 The content of the subsidiary window «Cooler Controls»

<b>LD t° - stabilization control</b> time depended graph	Shows the relative changes (in %) in laser diode TEC driving current concerned with stabilization of the laser diode temperature.
<b>LC t° - stabilization control</b> time depended graph	Shows the relative changes (in %) in active laser crystal TEC driving current concerned with stabilization of the active laser crystal temperature.

**Warning:** The laser environment operation temperature should be in the range of 10 to 30 °C. It can be set to higher environment temperature range, but depends on the power level of the pumping diode. The humidity should be below 90 %.



### 3.4 Turning the laser on and off

First, see section 3.2 or 3.3 to prepare the laser for emitting. Please use appropriate laser goggles before turning laser on. Ensure that the laser shutter is open. To turn laser on in standalone mode press **ON** button on the front panel of the laser diode driver. To turn laser on in remote control mode press **LD ON/OFF** button in the main window of the A310 Remote Control software. The button became green with label **LD ON**. The **Power** and **ON** LED at the front panel of the laser diode driver light permanently, the LCD Display shows **LD ON** status and current values of laser diode temperature and current.

To turn laser off in standalone mode press **OFF** button on the front panel of the laser diode driver. To turn laser off in remote control mode press **LD ON/OFF** button in the main window of A310 Remote Control software. The button became grey with label **LD OFF**. The **Power** LED at the front panel of the laser diode driver lights permanently, **LD** LED starts blinking and LCD Display shows **READY ON** status and current value of laser diode temperature.

#### Warning:

**Always wear suitable laser goggles to protect your eyes.**

## 4. Laser specifications

Table 4.1 Sample specifications of 532-Q Laser

Wavelength	532 nm
Active laser material	Nd <sup>3+</sup> :YAG
Q-switch material	Cr <sup>4+</sup> :YAG
Average power	>50mW
Pulse width	~2 ns
Repetition rate	0...20 kHz
Pulse to pulse jitter (rms) @ 8 kHz	< 3%
Beam waist (diameter) @ 1/e <sup>2</sup>	240 μm
Beam divergence (half angle)	3 mrad
Extinction ratio of polarization	> 50:1

The operating temperature range of the laser system is from 10°C to 30°C and the storage temperature range for the system is from 0°C to +50°C.

The dependencies of the main laser output parameters (average output power, repetition rate and pulse energy) from the set up laser diode current are shown on the Figures 4.1 - 4.3.

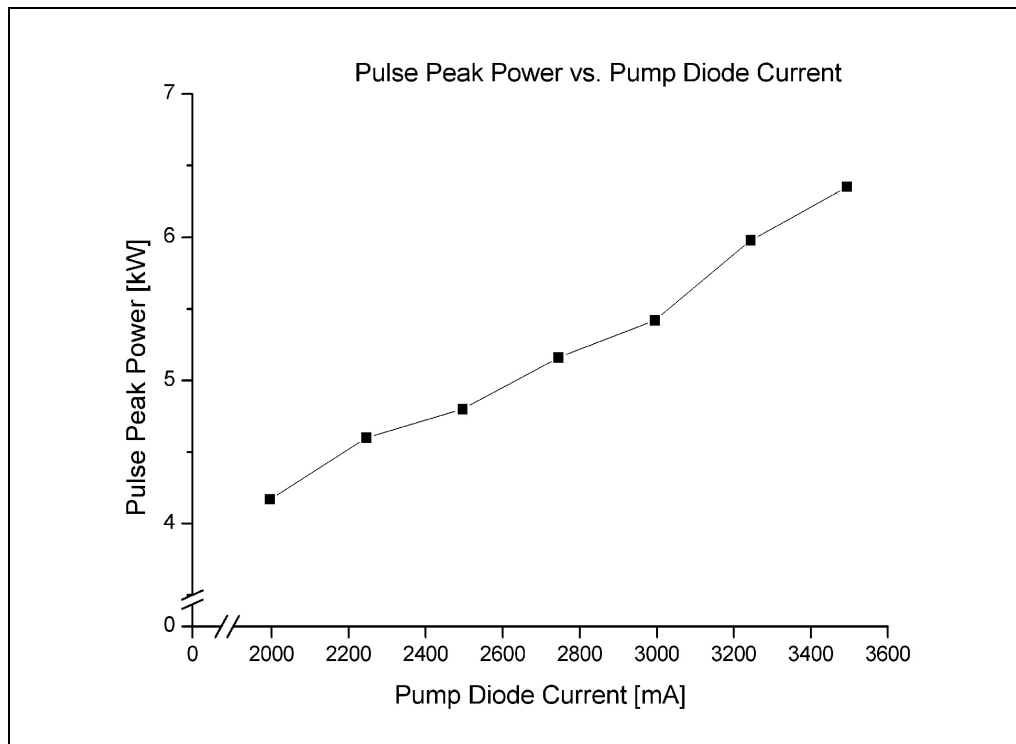


Figure 4.1 The pulse peak power versus laser diode current.

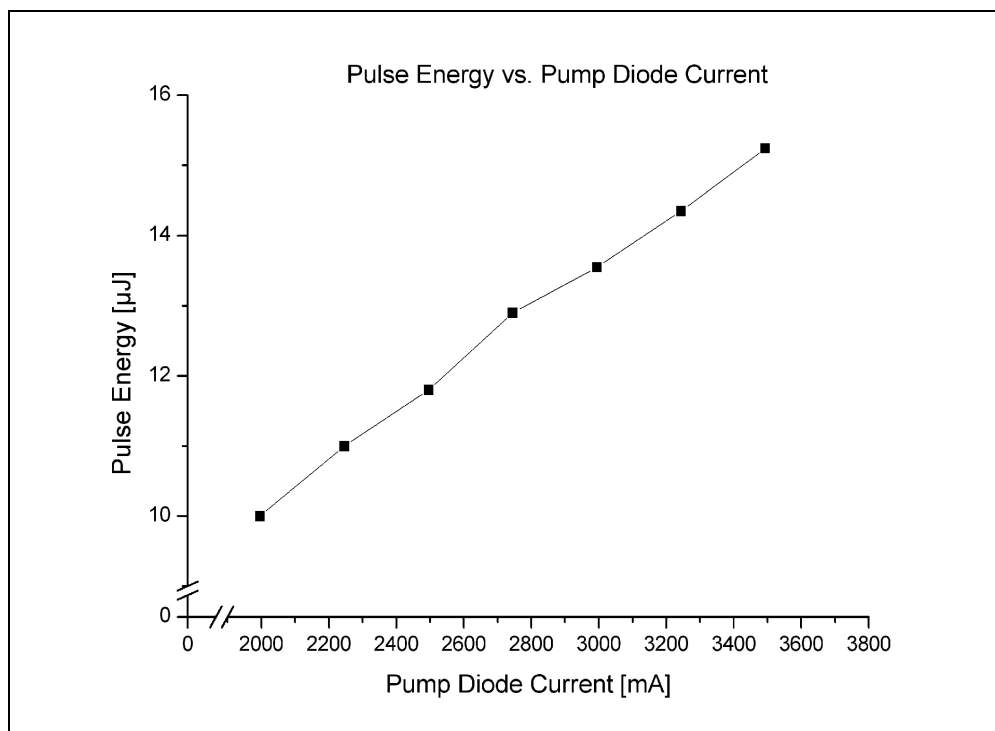


Figure 4.2 The pulse energy versus laser diode current.

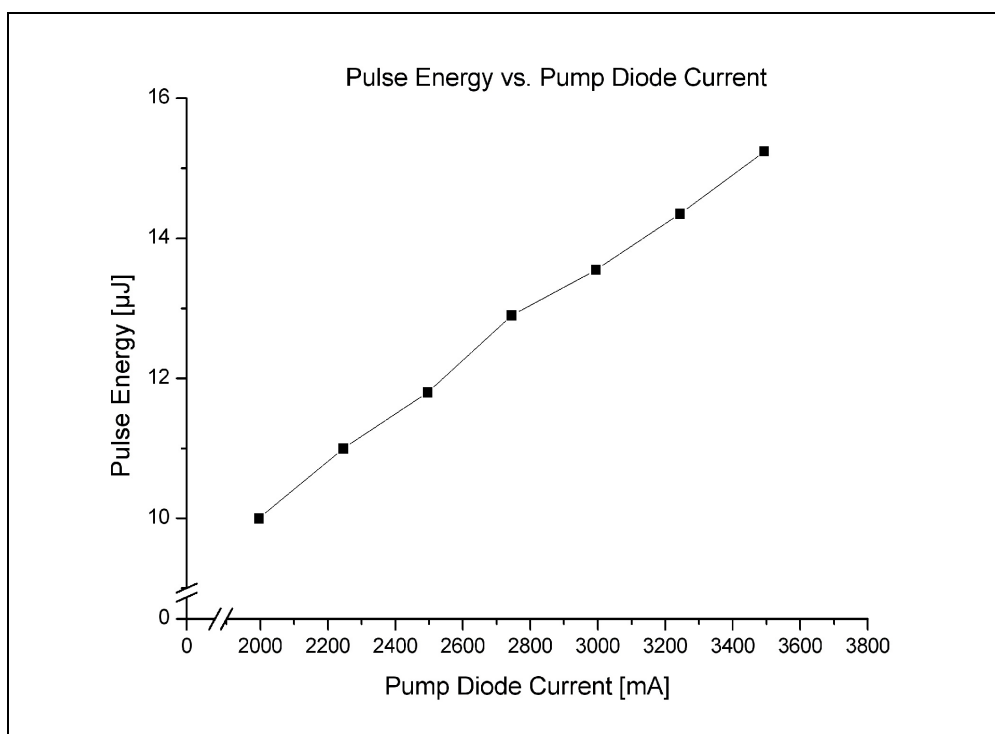


Figure 4.3 The pulse repetition rate versus laser diode current.

## 5. Warranty

IMPEX – HighTech 532-Q Laser OEM is warranted to be free of defects in material and workmanship for 12 month from date of shipment. The warranty shall not cover any damage incurred during shipping. When the product is received by the customers, the shipping container and its content should be inspected for any damage incurred during shipping. In order to obtain service under this warranty, the customer must notify IMPEX – HighTech of the defect before the expiration of the warranty period and make suitable arrangements for the performance of service. In all cases the customer will be responsible for properly packing and shipping the product back to IMPEX – HighTech, with shipping charges prepaid. If the product is not properly packed, it will be damaged in shipping and the warranty will be avoided.

This warranty shall not apply to any defect, failure, or damage caused by improper use, failure to observe proper operating procedures per the product specifications (see section 3), or improper / inadequate maintenance. IMPEX – HighTech shall not be obligated to furnish service under this warranty 1) to repair damage resulting from attempts by personnel (other than IMPEX – HighTech representatives) to repair or service the product; 2) to repair damage resulting from improper use or connection to incompatible equipment; 3) to repair damage resulting from operation outside of the operating environmental specifications of the product; 4) to repair damage resulting from improper packaging of the product in order to return it to IMPEX – HighTech.

Rheine, 27.02.2008

Version 1.1

**IMPEX – HighTech**  
Hovesaatstr. 6  
48432 Rheine  
Germany  
Phone: +49(0)5971 981 650  
FAX: +49(0)5971 981 659